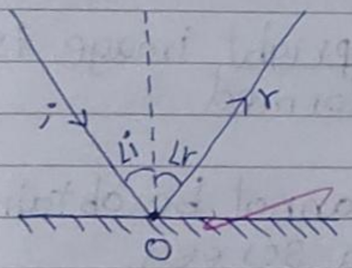
3/3/25
Monday

LIGHT - REFLECTION AND REFRACTION

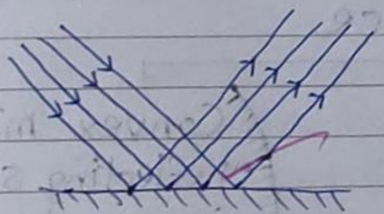
* Reflection of Light
The phenomenon of bouncing back of light in the same medium on striking any surface.



Laws:
(i) Incident ray, reflected ray, normal & point of incidence lie on the same plane
(ii) $\angle i = \angle r$

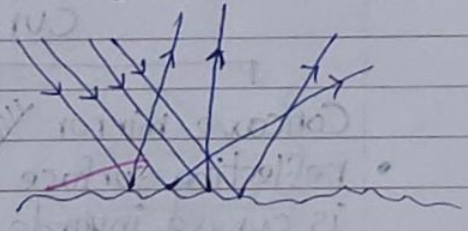
* Types of Reflection

(i) Regular reflection



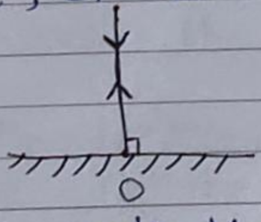
Smooth suface

(ii) Irregular reflection



rough surface.

>> When the light ray falls perpendicularly on a surface, $\angle i = \angle r = 0°$.



The ray retraces its path.

>> Laws are applicable in all cases - regular reflection, irregular reflection or the perpendicular reflection.

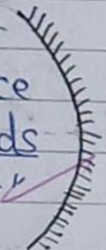
* Image - When the light rays from the object, after reflection, actually meet or appears to meet.

Real (original) | Virtual (Imaginary)

Real image	Virtual image
Formed when light rays actually meet after reflection	Formed when light rays appear to meet after reflection
Inverted image is formed	Upright image is formed
Can be obtained on a screen	Cannot be obtained on a screen.

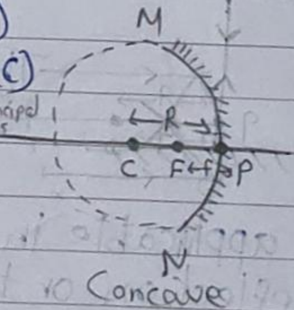
Spherical mirrors
curved surface

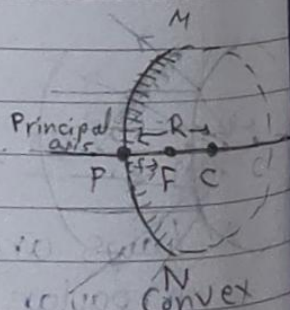
Concave mirror
- reflecting surface is curved inwards
- "converging mirror"

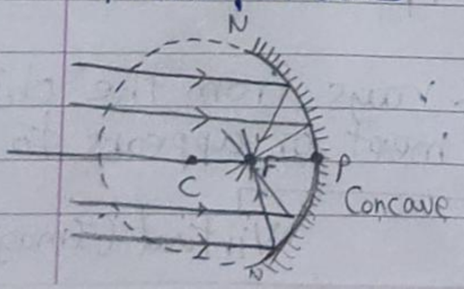


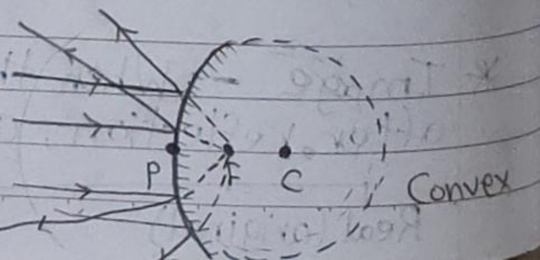
Convex mirror
- reflecting surface is curved outwards
- "diverging mirror"

* Terms related to spherical mirrors :
Pole (P)
Radius of curvature (R)
Center of curvature (C)
Principal focus (F)
Aperture (MN)
focul length (f)
Principal axis









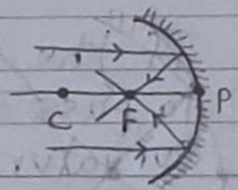
~~Principal focus and focal length of con~~

Concave	Convex
• F is infront of mirror	• F is behind the ~~pape~~ mirror
• Image in front of mirror	• Image behind the mirror
• Known as "converging mirror"	• Known as "diverging mirror"
• Curved inwards	• curved outwards

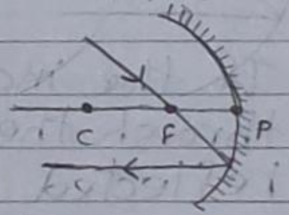
* Rules for drawing Ray diagrams

Concave mirror

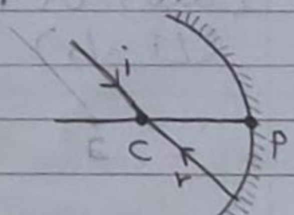
1. If the incident ray ∥ to the principal axis, then the reflected ray passes through the Focus.



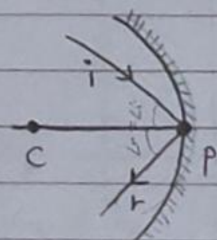
2. If the incident ray passes through the Focus, then the reflected ray passes ∥ to principal axis.



3. If the incident rays passes through the centre of the curvature, then the reflected ray passes in the same direction



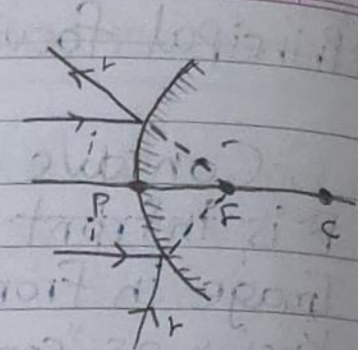
4. If the incident ray passes through the pole, the the reflected ray follows the laws of reflection.
$\angle i = \angle r$



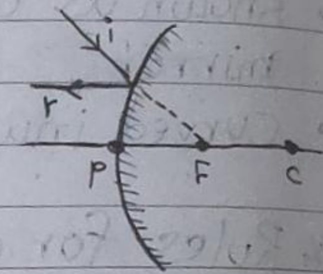
(Extra space)

Convex mirror

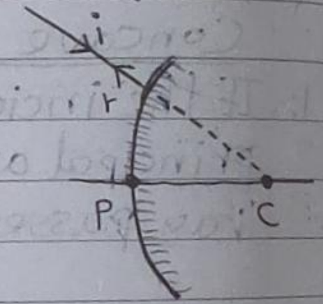
1. If the incident ray || to the principal axis then the reflected ray appears to pass through the focus



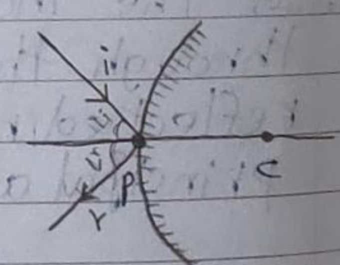
2. If the incident ray appears to pass through the focus, then the reflected ray passes ~~the~~ || to principal axis



3. If the incident ray appears to pass through the centre of curvature then the reflected ray passes in same direction



4. If the incident ray passes through the pole, then the reflected ray obeys the Laws of reflection.
   ($\angle i = \angle r$)



* P.O.O - Position of object
P.O.I. - Position of image
N.O.I - Nature of image
S.O.I - size of image

Ray diagrams (Concave mirror)

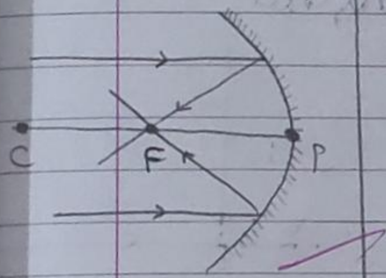
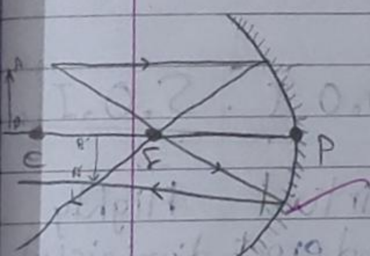
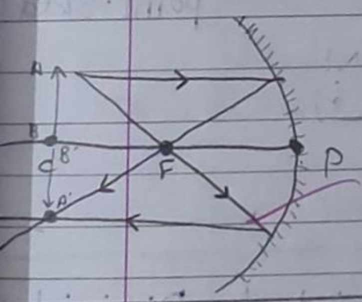
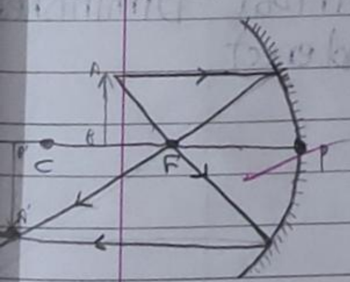
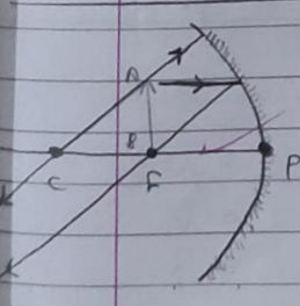
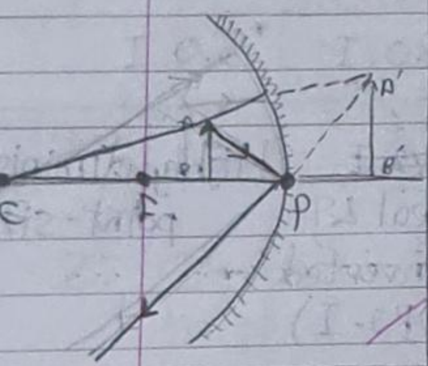
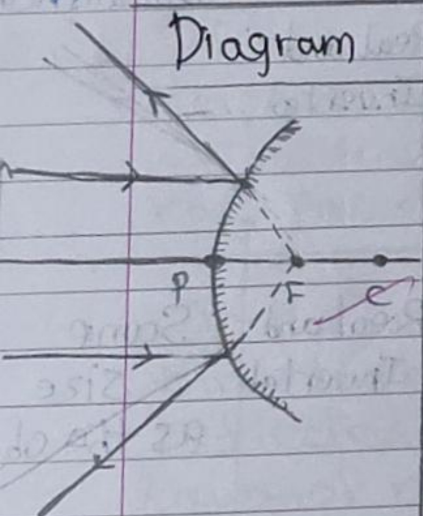
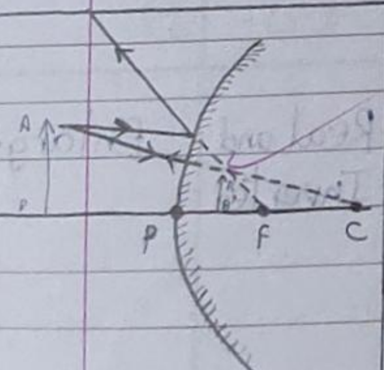
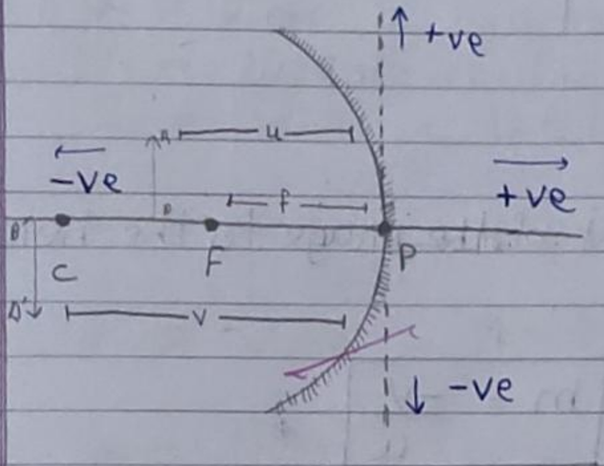
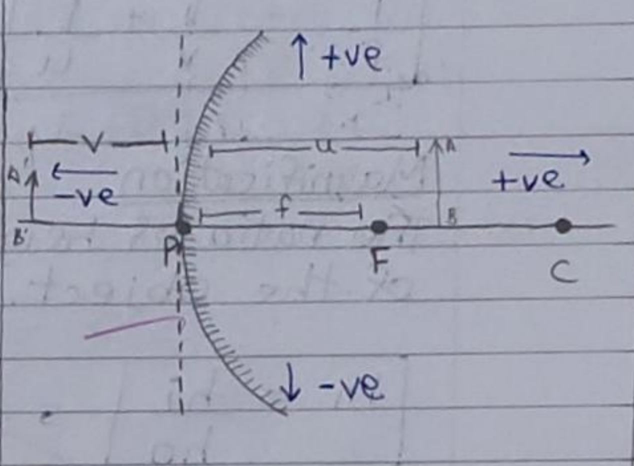
Diagram	~~Posi~~ *P.O.O	*P.O.I	*N.O.I	*S.O.I
	At Infinity ∞ Rule - (1)	Focus (F)	~~R&I~~ Real & Inverted (R&I)	Highly diminished point-sized
	Beyond Centre(C) Rule - (1)(2)	between b/w C & F	R&I Real and Inverted	Diminished
	At Centre (C) Rule - (1)(2)	At Centre (C)	Real and Inverted	Same size as the object
	Between C and F. Rule - (1)(2)	Beyond Centre (C)	Real and Inverted	Enlarged
	At Focus (F) Rule - (1)(3)	At Infinity ∞	Real and Inverted	Highly Enlarged

Diagram	P.O.O	P.O.I	N.O.I	S.O.I
	Between Focus and Pole Rule - ③④	Behind the mirror	Virtual and erect	Enlarged

Ray diagrams (convex mirror)

Diagram	P.O.O	P.O.I	N.O.I	S.O.I
	At Infinty ∞ Rule - ①	At Focus behind the mirror	Virtual and erect	Highly diminished point-sized
	Between Infinity ∞ and Pole(P) Rule - ① ③	Between Pole(P) and Focus (F) (Behind the mirror)	Virtual and erect	Diminished

Sign Conventions for Spherical mirrors. IMP

	
Concave mirror	Convex mirror

- All distances can be measured from pole.
- All measured distances in front of mirror are taken -ve
- All measured distances in back of mirror are taken +ve.
- All distances above and ⊥ (perpendicular) to the principal axis are +ve.
- All distances below and ⊥ to the principal axis are -ve.

Concave	Convex
u = -ve (always)	u = -ve (always)
v = -ve (Real → Case 1-5) +ve (Virtual → Case 6)	v = +ve
f = -ve	f = +ve
ho = +ve (Always)	ho = +ve (always)
hi = -ve (Real → Case 1-5) +ve (Virtual → Case 6)	hi = +ve

u = object distance
v = image distance
f = focal length

ho = height of the object
hi = height of the image

Date:

Mirror Formula

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

Magnification

The ratio of height of the image to the height of the object.

$$m = \frac{h_i}{h_o} \quad , \quad m = \frac{-v}{u}$$

If: $m = 1 \Rightarrow h_i = h_o$

$m > 1 \Rightarrow h_i > h_o$

$m < 1 \Rightarrow h_i < h_o$

$m = +ve \rightarrow$ When image is virtual.

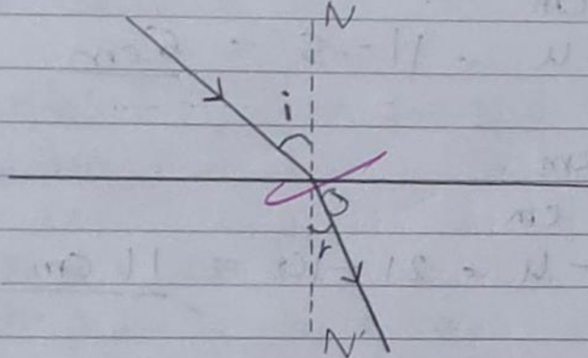
$m = -ve \rightarrow$ When image is real.

[redacted] Good

REFRACTION OF LIGHT

>>> The phenomen of change in path of light in going from one medium to another medium [bending of light]

>>> In refraction, i ≠ r

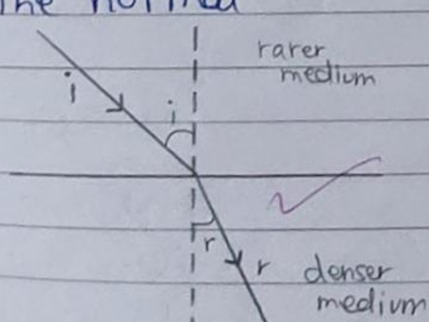


- Causes of refraction

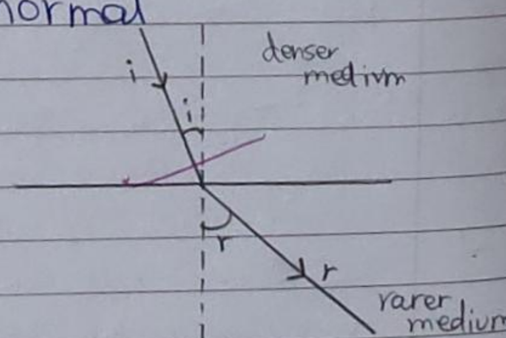
1. Speed of light changes with a change in medium
2. Direction of light also changes, therefore, velocity also changes

- Bending light

Case 1	Case 2
>>> Rarer medium to denser medium	>>> Denser medium to rarer medium
>>> Speed of light decreases	>>> Speed of light increases
>>> Light bends towards the normal	>>> Light bends away from the normal



$\angle i > \angle r$



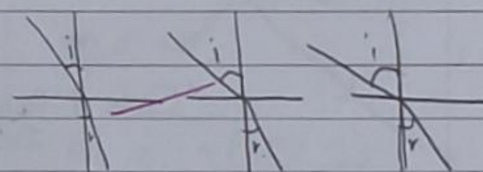
$\angle i < \angle r$

- Laws of refraction

1. Incident ray, refracted ray and normal point of incidence lie in the same plane, but different medium
2. When the speed of light goes from one medium to another medium, frequency does not change but velocity [speed with direction] and wavelength [colour of light] change.

Snell's law:

$$\frac{\sin i}{\sin r} = \text{Constant}$$



- Refractive Index [optical density)

>>> Denoted by letter n

>>> Refractive index of medium 2 with respect to medium 1

$$n_{21} = \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}}$$

$$\boxed{n_{21} = \frac{v_1}{v_2}}$$

Air - rarer - n↓ v↑

Glass - denser - n↑ v↓

>>> Refractive index of medium 1 with respect to medium 2

$$n_{12} = \frac{\text{Speed of light in medium 2}}{\text{Speed of light in medium 1}}$$

$$\boxed{n_{12} = \frac{v_2}{v_1}}$$

* Absolute refractive index

$$\boxed{n = \frac{c}{v}}$$

>>> Speed of light in air / vacuum (c) = 3×10^8 m/s

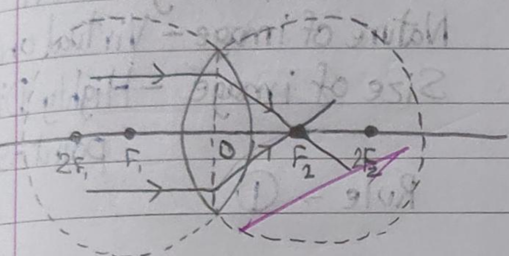
>>> Speed of light in water (v_w) = 2.25×10^8 m/s

>>> Speed of light in glass (v_g) = 2×10^8 m/s

>>> [redacted]

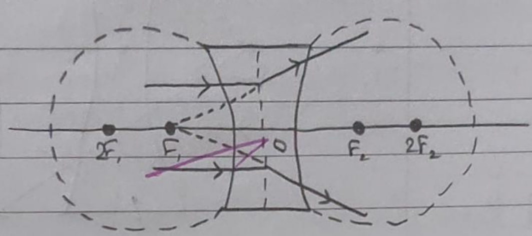
Spherical lenses

Convex lens



- curved outwards
- thicker at the centre, thinner at the edges
- converging lens
- Image at F_2

Concave lens



- curved inwards
- thinner at the centre, thicker at the edges
- diverging lens
- Image at F_1

Terms related to spherical lenses

1. Centre of curvature
2. Radius of curvature
3. Focal length
4. Optical centre - centre (geometrical point) of lens
5. Principal Focus
6. Principal axis

Uses:

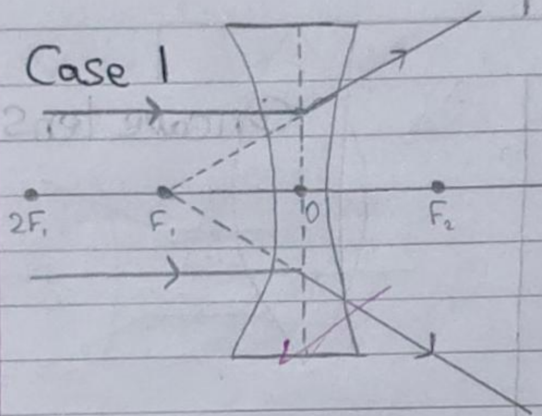
Convex – Magnifying
– Microscope
– Telescope
– Farsightedness
– Camera

Concave – Peepholes
– Spyholes
– Shortsightedness

>>>>>

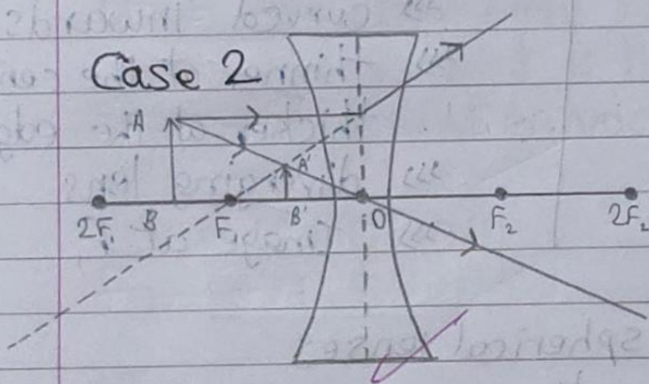
Ray diagrams of concave lens

Case 1



Position of object - At ∞
Position of image - At F_1
Nature of image - Virtual and erect
Size of image - Highly Diminished point-sized
Rule → ①

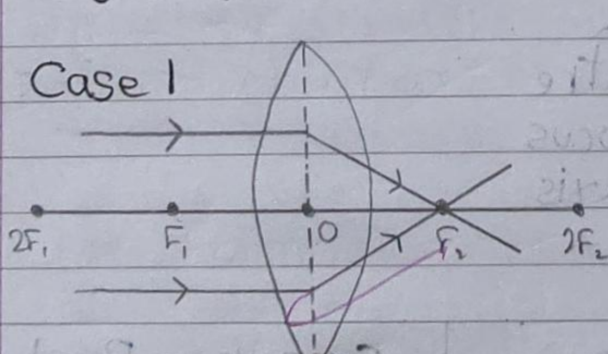
Case 2



Position of object - b/w ∞ and O
Position of image - b/w F_1 and O
Nature of image - Virtual and erect
Size of image - Diminished
Rule - ① ③

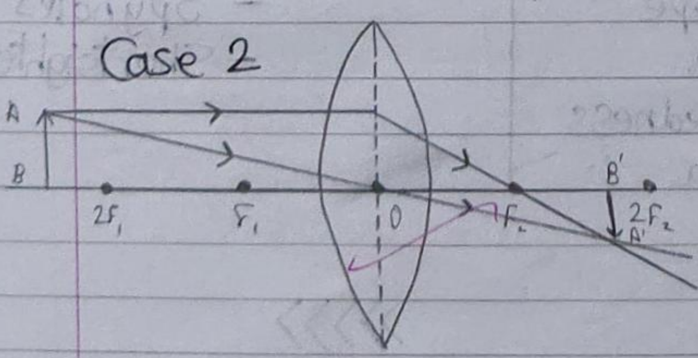
Ray diagrams of convex lens

Case 1



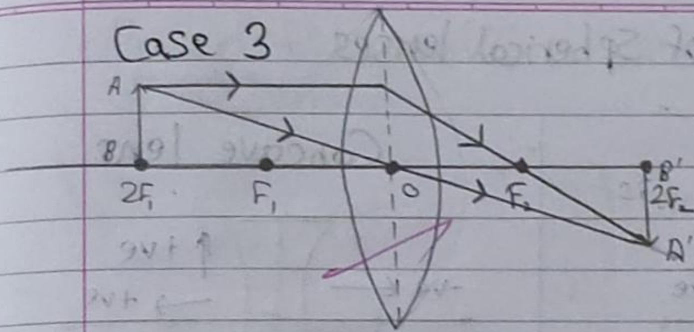
P.O.O - At ∞
P.O.I. - At F_2
S.O.I. - Highly Diminished (point)
N.O.I. - Real and Inverted
Rule - ①

Case 2



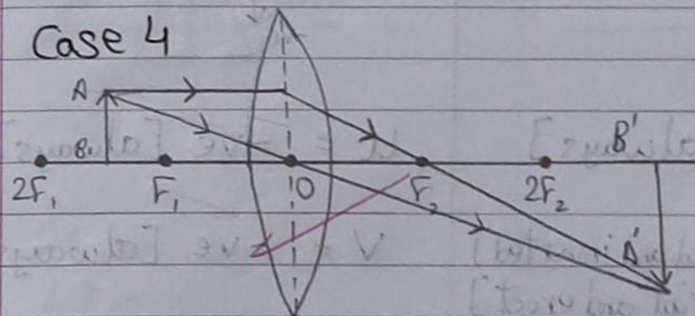
P.O.O - Beyond $2F_1$
P.O.I - b/w F_2 and $2F_2$
N.O.I - Real and inverted
S.O.I - Diminished
Rule - ① ③

Case 3



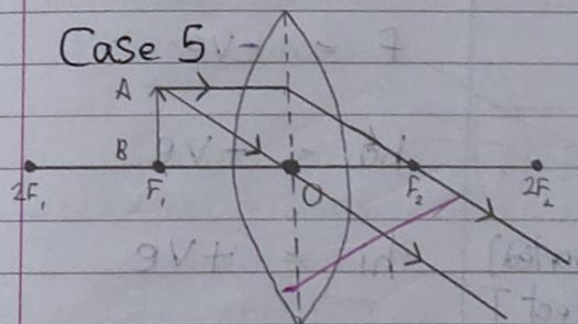
P.O.O — At $2F_1$
P.O.I — At $2F_2$
N.O.I — Real and Inverted
S.O.I — Same size
Rule — ① ③

Case 4



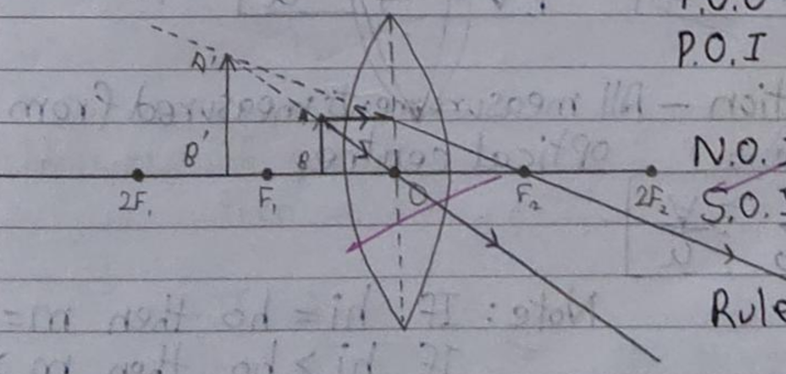
P.O.O — B/w $2F_1$ and F_1
P.O.I — Beyond $2F_2$
N.O.I — Real and Inverted
S.O.I — Enlarged
Rule — ① ③

Case 5



P.O.O — At F_1
P.O.I — At ∞
N.O.I — Real and inverted
S.O.I — Highly enlarged
Rule — ① ③

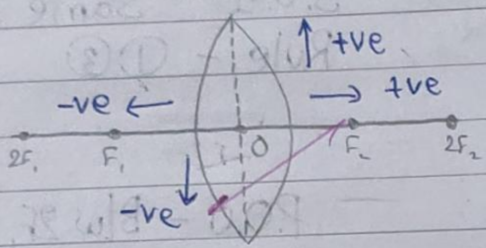
Case 6



P.O.O — b/w F_1 and O
P.O.I — on the same side of the lens as the object
N.O.I — Virtual and erect
S.O.I — Enlarged
Rule — ① ③

Sign Conventions of Spherical lenses

Convex lens



u = -ve [always]

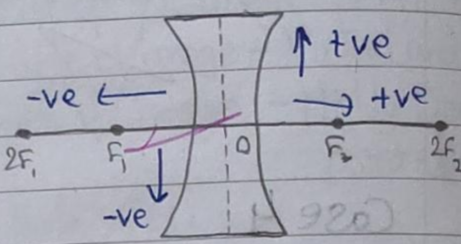
v = +ve [Real and inverted]
-ve [Virtual and erect]

f = +ve [always]

h_o = +ve

h_i = -ve [Real and Inverted]
+ve [Virtual and Erect]

Concave lens



u = -ve [always]

v = -ve [always]

f = -ve

h_o = +ve

h_i = +ve

Lens Formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$, $$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

Magnification – All measurements measured from optical centre

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

[redacted]

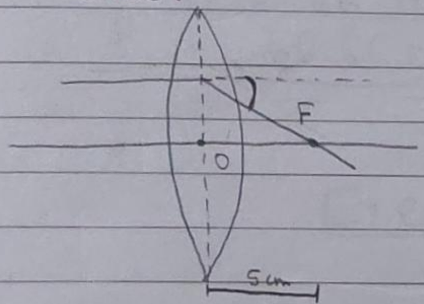
Note: If $h_i = h_o$ then $m = 1$
If $h_i > h_o$ then $m > 1$
If $h_i < h_o$ then $m < 1$

Page No.:
Date:

Power of Lens (P) - Converging or diverging capacity of a lens

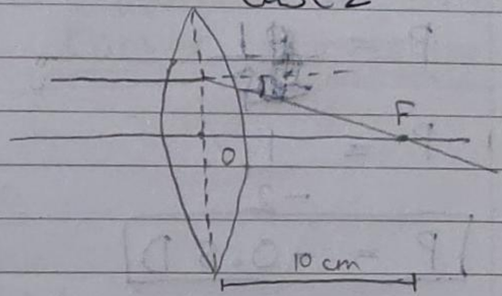
depends upon focal length

Case 1



$f\downarrow$ (less)
$\angle$ angle $\uparrow$ (more)
Converging $\uparrow$ (more)
$\therefore$ Power $\uparrow$ (more)

Case 2



$f\uparrow$ (more)
$\angle$ angle $\downarrow$ (less)
Converging $\downarrow$ (less)
$\therefore$ Power $\downarrow$ (less)

Power of lens $= \dfrac{1}{\text{focal length}}$

$$\boxed{P = \frac{1}{f}}$$

Unit of Power = Dioptre (D)

Unit of $\frac{1}{f} = \frac{1}{m} = m^{-1}$

$\therefore$ $\boxed{1D = 1m^{-1}}$

Note - If f +ve, then P +ve $\rightarrow$ The lens is convex.

- If f -ve then P -ve $\rightarrow$ The lens is Concave.